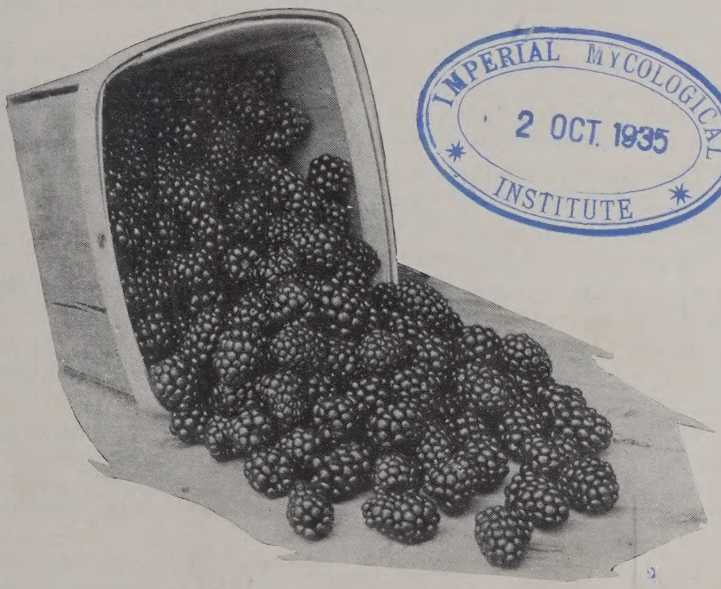
Wolf F. A & Dodge B O

FEBRUARY, 1926 BULLETIN No. 248

Anthracnose of Dewberries *and* Its Control



IMPERIAL MYCOLOGICAL INSTITUTE 2 OCT. 1935

The result of proper pruning and spraying.
Photo loaned by A. D. Robertson, Industrial Agent, S. A. L. Ry., Hamlet, N. C.

THE AGRICULTURAL EXPERIMENT STATION
OF THE
NORTH CAROLINA STATE COLLEGE OF AGRICULTURE
AND ENGINEERING

DR. R. Y. WINTERS, DIRECTOR
STATE COLLEGE STATION
RALEIGH

Bulletins of the Station will be sent to citizens on request

SUMMARY

Anthracnose is the most important disease affecting dewberries in the Sand Hills section.

This disease is not due to rainy weather, although frequent rains favor its development and spread, but is due to a microscopic plant called a fungus.

The spores or reproductive bodies of this fungus are formed on the surface of the diseased spots or lesions and are washed or splashed onto young canes, leaves, leaf-stalks, fruit-stalks and fruits and infection is evident in about a week's time.

The fungus passes the winter in the sunken grayish patches on canes and crops of spores are formed on these patches in spring at the time when growth of the vines is renewed.

Only young tender growth is subject to infection.

Anthracnose girdles the canes, causing them to die, and causes the berries to become scabby or brown, dry and woody.

Control of anthracnose depends upon (1) thoroughness in the removal and destruction of all growth immediately after harvest and (2) protection from infection by spraying.

There are three critical times at which applications should be made. The first occurs during August when the new growth is about a foot in length, the second, as soon as possible after the canes have been tied up in spring, and the third as soon as the petals have fallen.

Excellent commercial control of anthracnose is possible when attention is given to sanitation and when spraying is done according to this schedule.

Bordeaux mixture, 4-4-50, is recommended as probably the best spray material to employ.

In making new plantings care should be taken to avoid the introduction of anthracnose by means of the old infected cane stubs.

Fields on low ground are subject to greater injury from the disease than those on elevated sites. Excessive rainfall during spring favors the development of the "scabby berry" form of the disease.

Anthracnose of Dewberries and Its Control*

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INTRODUCTION

The growing of dewberries on a commercial scale in North Carolina is practically confined to that section of the State known as the Sand Hills. The first plantings of this crop were made about twenty years ago near the town of Cameron, N. C., and comprised in all a few small fields. The industry has gradually developed from this small beginning until it is now one of considerable importance, as witnessed by the fact that there are approximately 350 growers in this section some of whom have plantings of 25 to 40 acres and that the average yearly shipment for the past three seasons has been approximately 300 car loads of berries.

A survey of the dewberry disease situation, which has been in progress for several years, has shown that this crop is subject to a number of diseases which are of more or less economic importance. They include two root rots, diseases whose cause has not yet been definitely determined, double blossom caused by *Fusarium rubi* Wint., Septoria leafspot caused by *Mycosphærella rubi* (Westd.) Roark, Cercospora leafspot caused by *Cercospora rubi* Sacc., anthracnose caused by *Plectodiscella veneta* (Speg.) Burk., and in addition several little known diseases of the fruit one of which is called "nubbins" and another "piebald berries." Of these several diseases, anthracnose appears to be the most widely distributed and the most destructive.

When these studies were begun by the authors of this bulletin little information was available on the prevalence of dewberry anthracnose in North Carolina, on the effect of the disease on the fruit or on its control. For this reason coöperative work on this problem was undertaken by the North Carolina Agricultural Experiment Station and the office of Fruit Diseases, Bureau of Plant Industry, U. S. Department of Agriculture. However a considerable body of data based on the results of experiments in other states has been published while these studies were in progress. As a result the essential facts in the life history of the fungus causing the disease have been determined and considerable attention has been given to the conditions which influence the spread and development of the disease. Field trials on the prevention and control of anthracnose, which were based on these facts, have been made and had for their object the securing of definite information on certain specific questions on control. Among these questions were: (1) Can anthracnose be controlled? (2) Will the application of spray be necessary? (3) What kind of spray material will give the best results? (4) When should spray applications be made? (5) How many sprayings are necessary for satisfactory control? and (6) Will spraying pay?

*This work was done under a coöperative arrangement between the North Carolina Agricultural Experiment Station and the Bureau of Plant Industry, U. S. Department of Agriculture.

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It is the purpose of this report to briefly summarize the available information which bears on a proper understanding of the nature of the disease and of the organism which causes it. Such knowledge is believed to be necessary as a rational basis for the successful employment of the control measures which are herein recommended. In addition each of the pertinent questions mentioned above will be answered as fully as the data in hand warrant.

THE DISEASE

IMPORTANCE

Dewberry anthracnose varies in severity not only from season to season but also during the same season in adjoining fields so that no one can foretell the probable losses. During 1924, it was generally prevalent throughout the Sand Hills and fully half of the crop in certain fields was rendered unfit for market whereas no considerable losses were sustained in others. Two cases may be mentioned which are representative for the section. One grower near Lakeview, N. C., sustained an estimated loss of 100 thirty-two quart crates in a field of two and one-quarter acres. Another grower near Cameron, N. C., harvested an average of thirty-five crates per acre in a field of eight acres which, if anthracnose had not been present, would have yielded between 75 and 100 crates per acre.

During 1925, the weather was not as favorable for the development of the disease. However a conservative estimate places the losses at 15 per cent of the entire crop throughout the Sand Hills.

APPEARANCE

The most noticeable signs of the disease occur upon the canes which are girdled and which as a result die about the time the berries should mature, and upon the berries, which become brown and dry. It forms characteristic spots or lesions also upon the leaves, leaf-stalks, and fruit-stalks.

On Canes:—The spots upon the canes are circular, slightly sunken, grayish patches which vary in size from tiny specks to areas one-eighth to one-quarter of an inch across. Usually the border is reddish brown to purple. The spots may be so abundant as to run together and thus produce large irregular patches, Fig. 1. When this occurs the canes are encircled and in consequence the part above the diseased area dies. The drying up of the canes during the latter part of May or in June as the berries begin to ripen is a common result of girdling by anthracnose.

On Fruits:—It is only within recent years that plant pathologists have come to know that "scabby" berries are the result of infection by anthracnose. Many growers who are familiar with the disease on the canes do not appreciate that the same organism attacks the fruits. The infection of the fruit impairs both the yield and the quality. This form of the disease has been of common occurrence during the past few seasons. If infection occurs while the berries are young and all the druplets or carpels are involved they become brown, dry and woody and in consequence fail to ripen. If the berries have already begun to ripen the druplets become brown and sunken and such berries when picked make a pack of poor quality and unattractive appearance, Fig. 2.

On Leaves:—The disease on the leaves manifests itself by the presence of straw colored to yellowish brown irregular spots about the size of a pin head. These spots are bordered by a purplish margin. The dead central portion of the spots usually drop out and as a result the leaves are filled with holes or perforations or have a ragged appearance, Fig. 3. When the infection is severe the tissues surrounding the spots become yellow and the leaves fall off.

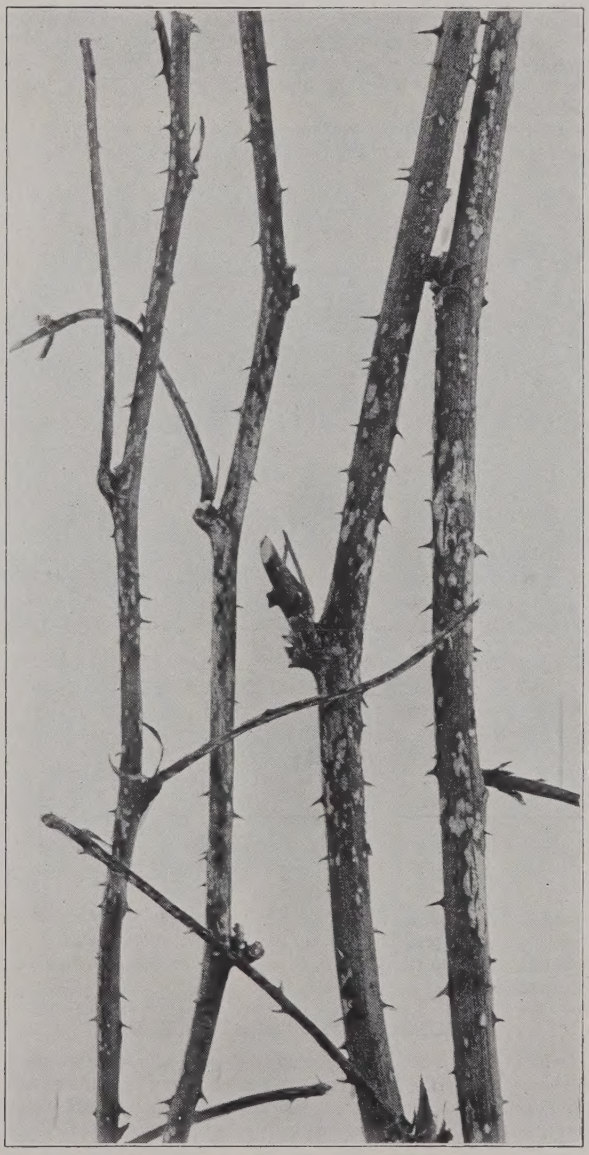

Fig. 1. Anthracnose on canes of dewberry.

The spots on the foliage caused by anthracnose may at first glance be confused with those formed by the Septoria leafspot disease. This disease is also generally prevalent but is the cause of no direct injury to the berries. The spots which it produces are larger than those of anthracnose and have grayish centers in which minute black pycnidia, the fruit bodies of the Septoria fungus, are embedded. Fig. 4.

On Leaf-stalks and Fruit-stalks:—These parts are very commonly affected and present the same type of injury as appears on the canes. Indi-

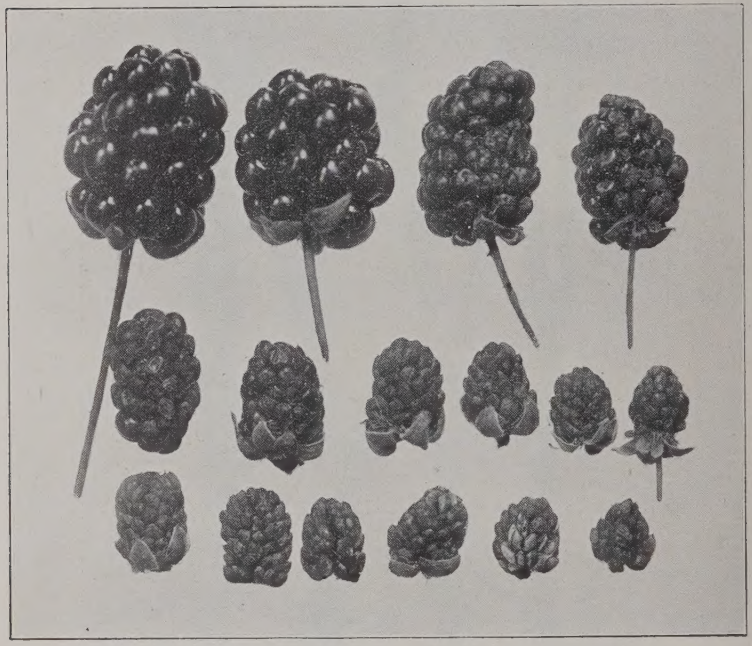

Fig. 2. Dewberries, some of which are slightly affected and others so seriously injured that they would never mature. The two large ones are healthy.

vidual spots are smaller, however, but when infection is severe the spots fuse and grayish scap-like patches are formed. These may girdle the leaf-stalk or fruit-stalk and cause the fruit to become dry or the failure of the leaf to function properly.

KIND OF PLANTS ATTACKED

Since farmers have come to recognize that a considerable number of crops such as apples, grapes, cotton, beans and watermelons, are subject to anthracnose diseases the question of whether or not the anthracnose fungus which attacks the dewberry is common to all is a logical inquiry. This query may be dismissed by stating that so far as known at present the fungus which causes anthracnose of dewberries is confined to the several species of

brambles which belong to the genus Rubus or to closely related genera such as the rose. There are included under this generic name both the eastern and western species of dewberry, the blackberry, of which the Snyder, Kittatany and Himalaya Giant are known to be subject to this disease, the Cuthbert and Antwerp red raspberry, the Cumberland black raspberry, the purple cane raspberry, and the loganberry.

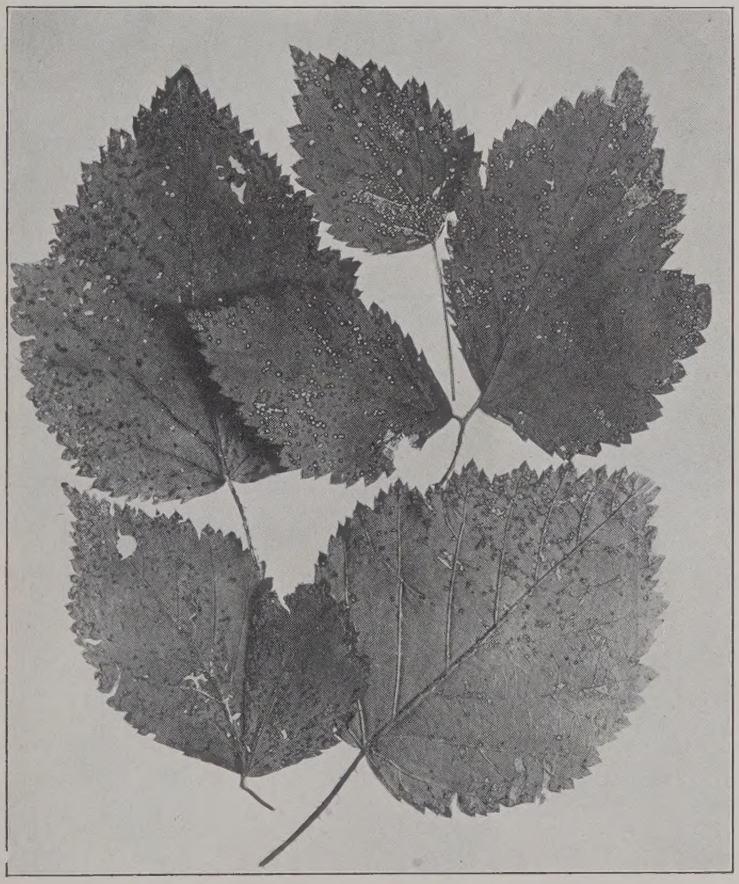

Fig. 3. The leafspot form of anthracnose.

THE ANTHRACNOSE FUNGUS

There are growers who are of the opinion that anthracnose is due to rainy weather, an opinion which is based upon the observation that rainy periods are favorable for its spread and best development. In reality it is a specific disease due to a fungus, Plectodiscella veneta. This fungus is known to possess

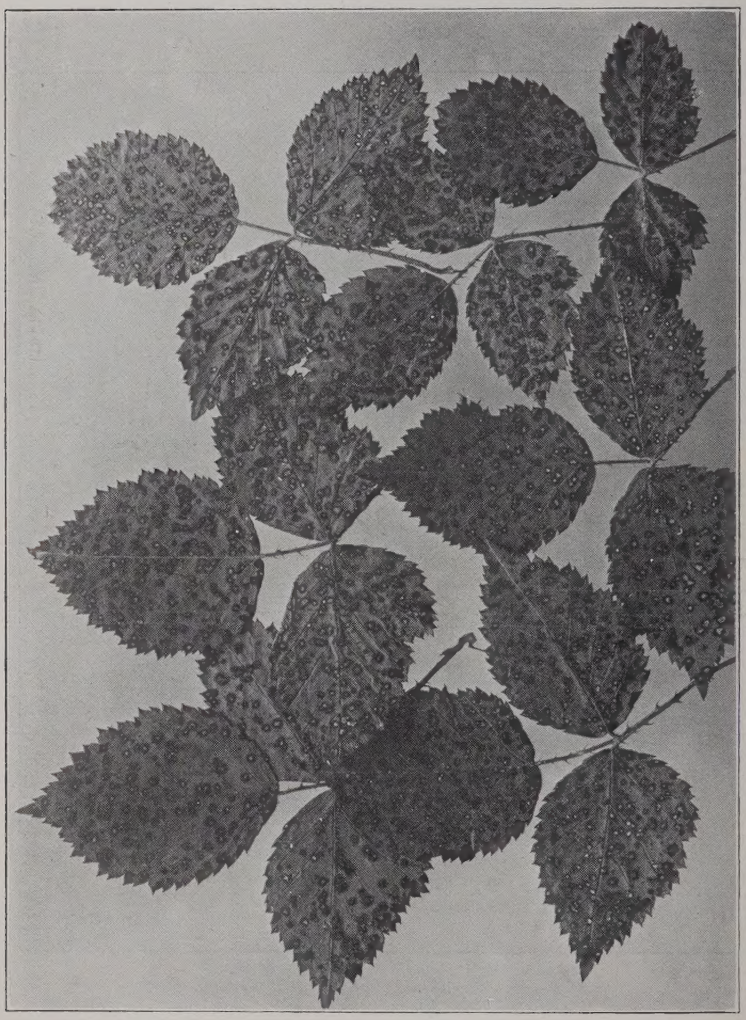

Fig. 4. The septoria leafspot disease which should be distinguished from anthracnose.

two stages, a conidial stage by which it is propagated during the growing season, and an ascosporic stage by which it survives the dormant or winter season. Each stage possesses spores or reproductive bodies which are capable of germination and growth and can develop within the tissues of the dewberry thereby causing anthracnose.

SEASONAL DEVELOPMENT OF THE DISEASE

If the season is favorable the new growth which is to bear the crop of the following year will have started early in August. The disease first appears on the young, tender canes during the period from about the middle of August to late August, at which time the canes are twelve to eighteen inches in length. The sources of inoculum for infections at this season are the old canes and leaves which were not removed from the field after all the canes had been

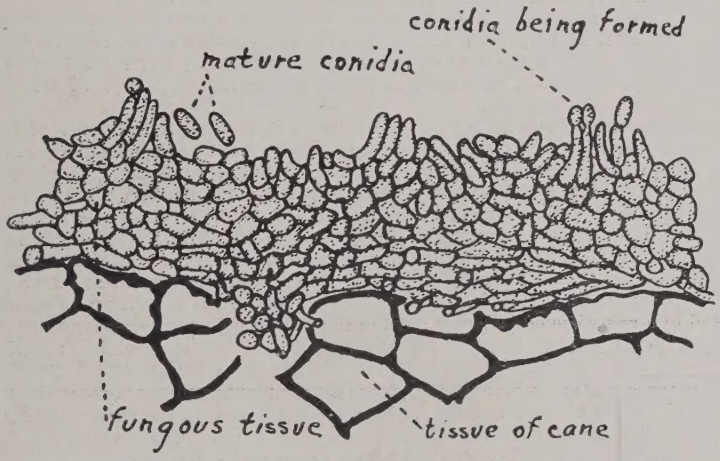

Fig. 5. Section through diseased grayish spot on cane on which the anthracnose fungus is fruiting. (Adapted from Burkholder.)

cut off. The first lesions appear on the tips of canes a few inches above the ground level. Successive crops of spores are formed at the surface of these lesions on young canes throughout the fall and these serve as the source of secondary infections.

In the spring as soon as growth is renewed, spores are produced at the surface of the overwintered lesions upon the canes. These are the primary source of infection at this time. Careful search has been made on these overwintered lesions and on canes which were cut off in July and examined from time to time during the fall, winter and spring, for an ascosporic stage or winter stage. The writers have not seen the winter stage on dewberry in North Carolina, and this stage is believed therefore to be rare in this region and to be of no importance in carrying the anthracnose fungus through the winter season. Jones (4) has observed the winter stage in abundance in spring in Wisconsin on black and red raspberry canes and considers it as the primary source of natural inoculum in spring. Burkholder (1) stated that it was of rare occurrence in New York and that the fungus passes the winter as a mycelium within the canes.

A period of four to seven days must elapse from the time the conidia lodge on the host to the first evidence of infection. Ten days to two weeks later the lesions will have matured and will be bearing new crops of spores. These spores stick together in small masses and are dislodged with difficulty by the wind. If, however, the masses are wet with dew or rain, the spores may be dripped or splashed to other parts of the plant or to nearby plants and give rise to new infections. This process may be repeated every time the plants are wet and there is in addition young growth to become infected. It appears that as the tissues of the leaves and canes approach maturity they are resistant to infection.

CONTROL

The studies on the life history and seasonal development of the anthracnose fungus have made it evident that the judicious employment of two measures is necessary to prevent and control this disease. Neither one is sufficient by itself nor more important than the other, yet each should supplement the other. The first of these may be termed sanitation, and consists in the removal and destruction of all of the above ground parts immediately after the harvest; the second, protection, and consists of the application of sprays at critical times to prevent infection.

Sanitation:—The cutting off at or just below the ground level of all growth just as soon as the picking season has closed is an effective means of preventing not only anthracnose, but the several other diseases, previously mentioned, which attack the above ground parts of the dewberry. This practice was begun as a means of controlling the double blossom disease and has proved to be a measure of prime importance in controlling other important diseases. Experience has shown that, entirely apart from the matter of disease control, there is no advantage in cutting off only the old growth and leaving the spring growth. These thick shoots which arise from the crown in spring tend to break when one handles them in tying them up, as is necessary early in the following spring, whereas the canes formed in late summer are slender, flexible, and bear an abundance of fruit buds. Some inexperienced growers leave the spring canes because they fear that the plants will not make sufficient growth in late summer and fall to bear a normal crop in the succeeding season. Under usual conditions, however, plenty of new cane growth can be secured after harvest provided the plants are properly fertilized.

The following recommendations for fertilizing dewberries in the sandy sections of North Carolina have been made by Prof. C. B. Williams, head of the Department of Agronomy:

Two applications of fertilizers are recommended per year as follows:

(1) The first one as soon as the canes are tied up in the spring.

(2) The second is made immediately after the fruit has been picked and canes, both old and new, have been cut off, the object being to promote rapid growth of vigorous new canes for next year's crop.

First Application—Use about 500 pounds per acre of the following mixture:

Acid phosphate, 16 per cent	**700 pounds**
Cottonseed meal, 7 per cent	**700 pounds**
Kainit, 12 per cent	**600 pounds**
Total	**2,000 pounds**

Second Application—Use around the plants about 500 pounds per acre of the following mixture:

Acid phosphate, 16 per cent	**500 pounds**
Cottonseed meal, 7 per cent	**1,100 pounds**
Sulphate of ammonia, 25 per cent	**100 pounds**
Kainit, 12 per cent	**300 pounds**
Total	**2,000 pounds**

Growers should insist on thoroughness in the removal and destruction of old canes for the reason that the anthracnose fungus can survive for a time on the old dead canes and can pass from these dead canes, if they are left tied to the posts or lying upon the ground, to the new growth which appears soon after this cutting off has been done.

Attention should also be directed to the fact that old cane stubs are customarily left on the plants to facilitate handling when new plantings are to be made. These old stubs are in some cases infected and thus serve as a means of disseminating anthracnose in new fields. Before such stock is set, therefore, the old stubs should be carefully pruned off.

Spraying:—Early in the course of these experiments it was found to be necessary to solve several problems relative to spraying so that our efforts were directed to the determination of whether or not spraying would be effective, when application should be made, whether Bordeaux mixture would cause injury to the foliage of dewberries, as is known to occur when it is applied to raspberries during the growing season, and whether the addition of a sticker or spreader is necessary to increase the effectiveness of the Bordeaux mixture. It was found during the first season that the variety Lucretia, the one most commonly grown in the Sand Hills, is not injured by Bordeaux mixture when it contains 4 pounds of blue stone and 4 pounds of quick or rock lime to 50 gallons of water. When the same quantity of air-slacked lime is substituted for quick lime slight injury follows and the spray does not spread nor adhere so well. This injury may be obviated by the use of six to eight pounds of lime to each four pounds of blue stone. There appears to be no advantage in the addition of soap or of calcium caseinate as a spreader and sticker when a good grade of quick lime is employed in making the Bordeaux and the spray is properly applied. Cases have been observed in which the foliage of the variety Austin Mayes was severely injured by Bordeaux.

The field studies have shown that there are three critical times at which applications of sprays should be made for a complete schedule. The first of these occurs during August when the new growth is about twelve to eighteen inches in length. The object of spraying at this time is to protect the young canes which are to bear the crop of the coming season and which may otherwise be girdled and become dry just before the berries should ripen. The next spraying should come in the spring as soon as possible after the canes have been tied up. This tying is usually done as soon as the danger of frost is over, so that the first spraying is normally made during the last week in March or the first week in April. Spraying at this time coats over the grayish patches on the canes on which the fungus would otherwise form a crop of spores to infect the new leaf and twig growth and will also protect the new growth from infection. The third spraying should be made at the close of the blossoming season when all or nearly all of the petals have been shed. This spraying has for its object the protection of the young berries.

As a result of satisfactory field trials during 1924 several growers, including Messrs. W. J. Johnson, Red Springs, N. C., R. E. Carrington, Sanford, N. C., Z. V. Pate, Laurel Hill, N. C., and Charles C. Jones, Cameron, N. C., coöper-

ated with the writers in spraying work during 1925. Some idea of the effectiveness of spraying can be gained from the tabulations of observations which follow. It was not feasible to pick fruit from sprayed and unsprayed portions three times per week throughout the picking season nor to determine the difference in yield between sprayed and unsprayed blocks. Instead careful count was made at the time of the third picking of the total number of berries both green and ripe, and of those affected with anthracnose, on a number of representative plants in three of the sprayed fields. Every grower knows full well that the appearance of the fruit in the market determines to a large extent the price obtained and that the presence of anthracnosed or scabby berries in a box mars its appearance and in consequence lowers the price which the buyer will offer. It is recognized that a portion of the diseased berries would have been marketable although of inferior quality, but the proportion of disease-free fruits may fairly be taken as a criterion by which to judge the effectiveness of spraying.

Table 1—The Relative Amount of Anthracnose on Sprayed and Unsprayed Dewberry Plants in the Field of Charles C. Jones, Cameron, N. C.

SPRAYED			UNSPRAYED		
Plant number	Total number of berries on plant	Number affected with anthracnose	Plant number	Total number of berries on plant	Number affected with anthracnose
1	210	5	1	285	41
2	125	1	2	300	15
3	190	0	3	352	25
4	192	0	4	240	10
5	170	0	5	312	4
6	97	0	6	330	52
7	230	0	7	264	8
8	210	3			
9	192	0			
Total count	1,616	9	Total count	2,083	155
Ratio of total number to diseased berries—180:1			Ratio of total number to diseased berries—17:1		

The field was sprayed three times and as nearly as possible according to the best schedule. A block of four rows near the center of the field was left for a control. It is evident first of all that individual plants vary in freedom from disease, a point which is equally striking in the records of other sprayed fields. It is equally evident in this field as well as in the others that plants differ greatly in vigor and productiveness. If account is taken of relative amounts of disease it will be noted that in that portion which was sprayed an average of 1 in every 180 berries was diseased, whereas 1 in every 17 berries were affected in the unsprayed portion.

Table 2—RELATIVE AMOUNT OF ANTHRACNOSE ON DEWBERRIES GIVEN THE LATE SUMMER AND POST-BLOSSOM SPRAYS AND ON THOSE RECEIVING ONLY THE LATE SUMMER SPRAY. FIELD OF E. P. PEARCE, HAMLET, N. C.

SPRAYED TWICE (LATE SUMMER AND POST BLOSSOM)			SPRAYED ONCE (LATE SUMMER)		
Plant number	Total number of berries on plant	Number affected with anthracnose	Plant number	Total number of berries on plant	Number affected with anthracnose
1	145	1	1	152	27
2	82	0	2	129	41
3	275	10	3	142	44
4	92	0	4	151	27
5	255	8	5	140	33
6	134	1	6	193	41
7	196	14	7	141	35
8	110	0	8	146	29
9	138	3	9	173	18
10	183	3	10	125	35
11	155	0	11	231	91
12	210	3	12	259	93
13	155	2	13	109	24
14	68	2	14	200	30
15	127	3	15	164	23
16	170	3	16	121	27
17	151	2	17	155	20
18	190	10	18	120	31
19	148	3	19	165	30
20	125	17	20	66	19
Total count.....	3,109	80	Total count....	3,063	729
Ratio of total number to diseased berries.... 39:1			Ratio of total number to diseased berries... 4:1		

This field has been sprayed three times and produced an average of 90 thirty-two quart crates per acre during the previous year. The entire field for the 1925 crop was sprayed during August, 1924, and again, with the exception of a few rows along one side of the field, in the following spring as soon as the flowers had been shed. The application after the canes had been tied up was omitted because there were practically no lesions on the overwintered canes. It will be noted that in the portion which was sprayed twice an average of 1 in 39 berries was affected with anthracnose while in that portion which was sprayed once an average of 1 in 4 berries was diseased. A single spraying in late summer is therefore of little value by itself in controlling anthracnose. It should be noted further that the large number of diseased berries on sprayed plants occurred in clusters which had evidently been missed in spraying. It might also be pointed out in explanation that it required six days to spray this field and that the portion in which the counts were made was sprayed last. When counts were made in that portion which was sprayed on the first two days, and in which anthracnose had been most severe during the two previous seasons, only 9 diseased berries were found in a row on sixteen consecutive plants, each of which bore from 150 to 350

berries. Apparently spraying was somewhat too late for most effective control in that portion of the field which was sprayed last. It cannot be too strongly emphasized that the results here and in the several other fields which came under our observation show that spraying for the protection of the berries must be done promptly at the close of the blossoming season and for best control should not be delayed until all of the petals have fallen.

Table 3—Relative Proportion of Anthracnose on Berries Which Were Sprayed Twice and Those Which Were Sprayed Three Times, on the Farm of Z. V. Pate, Laurel Hill, N. C.

SPRAYED TWICE (Late Summer and Post Blossom)			SPRAYED THREE TIMES (Late Summer, Dormant and Post Blossom)		
Plant number	Total number of berries on plant	Number affected with anthracnose	Plant number	Total number of berries on plant	Number affected with anthracnose
1	130	13	1	170	5
2	165	19	2	172	1
3	90	16	3	120	0
4	85	12	4	90	0
5	236	20	5	230	6
6	176	12	6	280	5
7	215	20	7	68	4
8	95	8	8	154	6
9	92	27	9	95	1
10	128	17	10	121	0
11	215	45	11	142	0
12	133	30	12	126	2
13	180	13	13	132	0
14	240	68	14	156	0
Total count	2,180	317	Total count	2,056	30
Ratio of total number to diseased berries	7:1		Ratio of total number to diseased berries	68:1	

Approximately half of this field, which was on low-lying land, was sprayed three times and the portion on higher ground was sprayed twice, the spraying in early spring being omitted from the regular schedule. It is evident first of all that two applications of spray were not sufficient to give adequate control. Here, as in the other fields which were properly sprayed, there was a greater difference in that portion which was sprayed twice and that sprayed three times than can be shown by the counts, since every fruit which had a single diseased spot was classified as affected.

THE COST OF SPRAYING

Naturally one of the first questions which the grower asks when the problem of anthracnose control is mentioned is "What will it cost to spray?" It is rather difficult to answer this question satisfactorily in a single sentence, since there are a number of factors which must be considered and which modify the total cost of the operation. In order to furnish a basis, however, for approximating the probable cost, the following tabulations are given of costs of spraying in 1925 in the several localities:

Table 4—COST OF SPRAYING EIGHT ACRES, 16,000 PLANTS, ON THE FARM OF CHAS. C. JONES, CAMERON, N. C.

Bluestone	180 lbs. @ 7 cents	$12.60
Lime	200 lbs. @ 1¼ cents	2.50
Labor	3 men @ $2.00 for 4 days	24.00
Labor	1 mule @ $1.00 for 4 days	4.00
Estimated depreciation on sprayer		15.00
Total cost		$62.10
Total number of plants sprayed (3×16,000)		48,000

It will be seen that the per acre cost for three applications in this field was approximately $8.00. If this is stated in terms of cost per plant for a single application, it will be seen that an average of between 7 and 8 plants can be sprayed for 1 cent.

Table 5—COST OF SPRAYING 35 ACRES, 70,000 PLANTS ON THE FARM OF E. P. PEARCE, HAMLET, N. C.

Bluestone	600 lbs @ 7 cents	$42.00
Lime	800 lbs. @ 1¼ cents	10.00
Labor	6 men, 12 days @ $2.50 per day	180.00
Labor	2 horses, 12 days @ $1.00 per day	24.00
Estimated depreciation on 2 spray outfits		30.00
Total cost		$286.00
Total number of plants sprayed (2×70,000)		140,000

The per acre cost for two applications as shown in Table 5 is approximately $8.00 which, if calculated on the basis of the cost per plant, would amount to 1 cent for spraying 5 plants. If the computation is made on the basis of the number of crates of berries required to pay for the cost of spraying this entire field with fruit selling at $3.50 per crate, it will be seen to require nearly 80 crates.

Table 6—COST OF SPRAYING 35 ACRES, 114,000 PLANTS, ON THE FARM OF Z. V. PATE, LAUREL HILL, N. C.

Bluestone	650 lbs @ 7 cents	$ 43.50
Lime	1,000 lbs @ 1¼ cents	12.50
Labor	2 men @ $2.00 and 3 men @ $1.50 for 12½ days	106.25
Labor	2 mules @ $1.00 for 12½ days	25.00
Estimated depreciation on 2 spray outfits		77.25
Total cost		$255.00
Total number of plants sprayed		255,000

Since the entire field containing 114,000 plants was sprayed twice and the lower portion three times, approximately 255,000 plants were sprayed at a cost of $255.00. If this be computed on the basis of the number of plants which were sprayed for 1 cent, it will show that for every cent expended 10

plants were sprayed. If these figures be expressed in the per acre cost for the two and one-half sprayings it will amount to about $7.25 per acre.

The cost of three applications of spray on the field of Mr. R. E. Carrington, Sanford, N. C., was nearly $10.00 per acre.

Among the different conditions which influence this range in cost from $7.25 to $10.00 per acre are size of plants, number of plants per acre, whether the plants are trained on stakes or trellises, the kind of spray outfit used, and the amount of spray wasted.

DISCUSSION

No sprayers adapted to use with dewberries are at present on the market. Most growers find barrel pumps which deliver the spray through two leads of hose under a pressure of 100 pounds very satisfactory. The barrel should be mounted on a sled provided with rollers to decrease traction. The two lines of hose may be fastened to cross-arms which carry the hose above the lines of stakes. This enables the operator to spray 3 rows on either side on each trip. A power sprayer which would deliver the material under pressure of 250 pounds would very probably be less wasteful of material, would cover the vines more quickly and thoroughly and thus decrease the labor cost and increase the effectiveness. Such outfits could not be employed satisfactorily, however, in rows 4½ to 5 feet apart, the usual distance between rows, but would require six-foot rows.

Anthracnose appears to be more prevalent in fields situated on low land than those on hillsides or on elevated sites. It may, in some seasons and in certain fields, cause insufficient loss to make spraying advisable. In others it will probably occur every year, as judged by its presence in serious forms in fields which have been under observation during the past three seasons. In such fields it will pay to spray every season. Whether or not three sprayings are necessary will depend upon the weather conditions at the time when infection normally occurs, and upon the abundance of inoculum. There is reason to believe that the effects of anthracnose are cumulative and that the disease reduces the vigor of the plants and thus decreases production each year. There is equally good reason to believe that the effects of spraying are cumulative in reducing the source of inoculum and thus in cutting down the number of sprayings necessary for commercial control of anthracnose.

Although the data which have been presented show the results of spraying during the season of 1925 only, they agree well with those of the previous season and are believed to be representative of what may be expected in any year.

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